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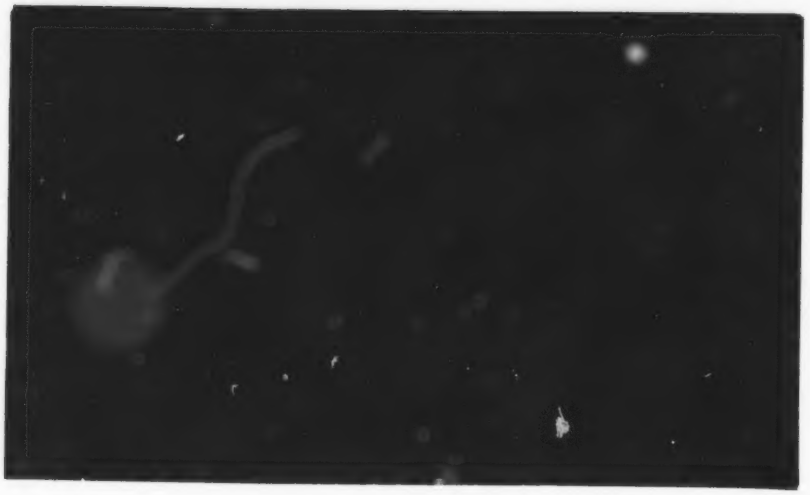

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ARE CAR PURCHASES SAVINGS?
AN ANALYSIS OF GERMAN HOUSEHOLDS

by

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ABSTRACT

We estimate a savings function in which savings, defined as increase in net wealth, alternatively exclude or include car purchases. We cannot reject the hypothesis that car purchase expenditures are part of savings and consequently constitute an element of the households' investment portfolios.

Key words: automobile demand, directly ordered data, correlation of residuals, economic distance, Federal Republic of Germany, household savings, propensity to save

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Zusammenfassung

Wir schätzen eine Sparfunktion, in welcher die Ersparnis, definiert als Nettovermögenszuwachs, alternativ den Kauf von Kraftfahrzeugen einschließt oder nicht. Die Hypothese, daß Ausgaben für den Kauf von Kraftfahrzeugen als Teil der Ersparnis und damit des Investitionsportfolios des Haushalts anzusehen sind, kann nicht verworfen werden.

Schlüsselbegriffe: Bundesrepublik Deutschland, direkt geordnete Daten, Haushaltserspamis, Nachfrage nach Kraftfahrzeugen, Korrelation der Residuen, ökonomischer Abstand, Sparneigung

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RESUME

Nous estimons une fonction d'épargne dont la variable dépendante définie comme variation de la richesse des ménages, comprend ou exclut les achats d'automobiles. Nous ne pouvons rejeter l'hypothèse que les achats font partie de l'épargne des ménages et ont en conséquence leur place dans les portefeuilles de placements.

Mots-clés: épargne, propension à épargner, données en ordre dirigé, corrélation des résidus, distance économique, République Fédérale Allemande.

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1. INTRODUCTION: THE PROBLEM

Savings, defined as increase in net wealth, are characterized in most studies as a portfolio of different financial assets or long term durable goods such as houses. Cars are normally not included, although they have typical properties of assets; for instance, they yield returns, change in value or are subject to risk just like bonds or shares. Germans, in particular, clearly take into account the resale values of cars when they make a car purchase, a "stylized fact" that points to the usefulness of an analytical inquiry of this question: we want to explicitly test the hypothesis that car purchase expenditures are considered by households as part of their long-term investments, using German household data for 1983. Naturally, a savings function based on this extended definition should not look very different from a "classical" savings function.

There is a strong economic policy interest in the question: if cars are considered by households as consumption items, one would expect changes in their prices to influence strongly the demand for other consumption goods whereas, if they are more akin to savings, one would expect strong linkages with the structure of portfolios. In the latter case, financial market policies would have an impact on car investment behavior; car prices would in return affect capital markets.

In our comparison of the "classical" and the "enriched" specifications of the savings functions, we base our comparison on their different characteristics:

(i) the functional form,
(ii) the value of the partial derivatives of the dependent with respect to the independent variables,
(iii) the distributional properties of the error term, namely heteroskedasticity and autocorrelation.

Whereas the first and the third points are clear, the second needs some explanation. Assume that there exists a household investment portfolio including typical assets like bonds, shares, houses, precious metals, etc. Certain types of investments can be given by linear combinations of other investments which are at the frontier of the portfolio. If car purchases are an investment that may be characterized by a combination of existing assets, then a "savings" function which includes these investments must be identical to a function which excludes them. By identical, we especially stress the partial derivatives because, at the margin, an additional DM earned could either be spent on a car or on a combination of assets with the same properties as the car investment.

If the two functions are different, we cannot classify and evaluate the function including car investments as it could either be the result of a new efficient type of investment or show that car purchase is consumption.

Equal partial derivatives of the two functions are therefore used as a sufficient but not necessary condition for the maintained hypothesis that car expenditures are a form of savings. Partial derivatives are a better indicator than elasticities, which are weighted by the dependent variable and necessarily smaller in absolute terms once car investments are included in the portfolio. Elasticities may, of course, give further results of interest, but are not as appropriate as partial derivatives for our purposes.

2. FORMULATION WITH GERMAN DATA

2.1 Economic Specification and Data Particulars

We employ the following household savings function borrowed from previous work that will be referred to shortly:

$$SAV_i = f(SSC_i, PER_i, AGE_i, TAX_i, GIN_i) + u_i, \qquad (1)$$

where i is an observation subscript (i = 1,2,...,n) and the variables are defined as (units in parentheses)

- SAV: Savings: increase in net wealth (DM);
- SSC: Contributions to Social Security: compulsory payments to the public old age insurance system (DM);
- PER: Number of persons in the household;
- AGE: Age of the household's head;
- GIN: Gross household income, including transfers (DM);
- TAX: Income, capital and wealth taxes (DM);
- u: Regression residual.

The 1983 data on German household income and expenditure are published by the Federal Statistical Office of Germany (1986). This statistical source contains data for different types of households (retired persons, farmers, self-employed, public officials, white collar workers, blue collar workers), all of which were retained for this analysis.

Income and expenditure data are available for different levels of net income either by household size or by age of the household head. This means that the savings functions could either be specified by including the variable "age" or the variable "number of persons". It has been shown in earlier studies with similar data (BLUM, 1985) that excluding either one leads to considerable

estimation problems. Consequently, a data set for every type of household was generated by merging both sets; as the two subsets were taken from the same sample of households with the same distribution, the missing variable in one data set was replaced by the average value of the variable in the other set. In doing so, it is assumed that the resulting error is smaller than that obtained by keeping distinct data subsets and specifying models without either the age of the household head or the number of persons per household; in a linear model, our merging procedure will yield unbiased estimators. Various tests with similar data for the year 1978 (BLUM and GAUDRY, 1990) were consistent with the appropriateness of the procedure.

2.2 Econometric Specification

In the absence of strong a priori views on the functional form of (1), it is appropriate to use the Box-Cox specification and correct simultaneously for heteroskedasticity and autocorrelation according to the strategy defined in GAUDRY and DAGENAIS (1979):

$$y_t^{(\lambda_y)} = a_0 + \sum_{j=1}^{m} a_j * X_{jt}^{(\lambda_j)} + u_t , \qquad (2)$$

where the a_j are coefficients of the variables and the transformation is defined as

$$X_j^{(\lambda_j)} = \begin{cases} \dfrac{X_j^{\lambda_j} - 1}{\lambda_j} & \text{if } \lambda_j \neq 0, \\ \ln X_j & \text{if } \lambda_j = 0. \end{cases} \qquad (3)$$

The linear case is obtained by setting all λ_j to 1. Setting the same values to zero yields the log model. But it is clearly important to correct for autocorrelation and heteroskedasticity in order to obtain a final residual error of zero mean and constant variance.

Correcting for heteroskedasticity is of special importance when flexible forms are used on the variables of (1) and modify the

error variance. We use the general error term specification:

$$u_t = \exp[\beta_0 + \beta * Z_t^{(\lambda)}]^{0.5} * v_t \quad . \tag{4}$$

Autocorrelation of multiple orders may result from information in the endogenous variable not explained by the deterministic part of the savings function. In time series, a convenient approach is to identify the proper structures with Box-Jenkins techniques to determine the number of distinct orders required to obtain white noise residuals w_t .

$$v_t = \sum_{q=1}^{Q} \rho_q * v_{t-q} + w_t \quad . \tag{5}$$

By defining a "residue impact criterion" stressing the fact that, in addition to the usual meaning of autocorrelation in time series, it is possible to give an economic interpretation to autocorrelation in cross sections, the correlation of residues between households of different (here: higher) income can be tested. Specifically, we defined a directly ordered impact criterion (DORIC) by relating each household to a richer group:

[Assume that each household looks up to a higher income household a given economic distance away] (6)

In our stratified sample, in which the number of households in each group was given, this involved repeating observations according to their frequency. The highest number of repetitions was found to be 12, thus looking up 13 observations never involved relating to the same group. Using 13th order autocorrelation implied that households looked up 3% higher in the distribution of income. A detailed description of the methodology can be found in GAUDRY and BLUM (1988) and BLUM and GAUDRY (1990).

3. RESULTS

Table 1 contains 6 columns: the first three pertain to the explanation of savings defined without including capital expenditures on cars and the last three to similar experiments performed with the "enriched" definition of the dependent variable. Columns 2 and 5 present the reference model of each function.

3.1 Reference Model for Both Savings Functions

In order to establish a reference model for both definitions of savings, a set of experiments was carried through:

(i) A linear regression was performed on all variables (fixed lambda = 1); results are given in Columns 1 and 4. A log-linear model was also tried. Resulting log likelihood values (not shown) were very low: -2776.789 and -3006.091, respectively.

(ii) A model with a single lambda common to the endogenous and the exogenous variables was estimated; the result is given in Columns 2 and 5. Attempts to use more lambdas, for instance one on the endogenous and the other one on all exogenous variables, were made but did not yield sufficient statistical gains to justify the additional parameter. The results shown in Column 2 and Column 5 were therefore retained as reference models. But before commenting on them, a description of the contents of the table is useful.

3.2 Reported Statistics and Reporting Format

The first part of the table contains partial derivatives of the expected value of the dependent variable and elasticities of the expected value of the dependent variable, both evaluated at the mean value of the variables, as well as t-statistics of the underlying regression coefficients computed conditionally upon the estimated value of the Box-Cox transformations used. An identifying group number for these transformations is also inscribed.

The second part contains functional form and residual error specification parameters and statistics. The third part contains general statistics associated with each experiment.

3.3 General Comments on the Reference Models

Some general comments on the results seem necessary at this point:

(1) Partial derivatives for all pairs of experiments are nearly identical and make very good economic sense. Only AGE, which is a socioeconomic and not a strictly economic variable, behaves differently. In both cases, the optimal functional form is the square root of all variables. All results are statistically highly significant with the exception of age in the function which includes car purchases. We conclude that car purchase expenditures are true investments within the households' portfolios.

Table 1: Models of Household Savings, Germany 1983

PARTIAL DERIV. E(y) (EP) / ELASTICITIES E(y) (EP) / (COND. T-STATISTICS)	COLUMN / DEP.VAR. =	1 TOT1SAV83	2 TOT1SAV83	3 TOT1SAV83	4 TOTSAVCAR83	5 TOTSAVCAR83	6 TOTSAVCAR83
HOUSEHOLD STRUCTURE							
age of head of household	TOTAGE83	-.174383e+01	.180637e+01	.171484e+01	-.202121e+01	.623733e-01	.116319e+00
		-.224	.273	.256	-.192	.007	.012
		(-3.14)	(4.84)	(4.47)	(-3.72)	(.15)	(.27)
		LAM 1	LAM 1	LAM 1	LAM 1	LAM 1	LAM 1
number of persons in household	TOTPERS83	.435697e+02	-.232798e+02	-.233087e+02	.322654e+02	-.207076e+02	-.209412e+02
		.240	-.151	-.149	.131	-.093	-.094
		(6.36)	(-3.73)	(-3.58)	(4.82)	(-3.33)	(-3.36)
		LAM 1	LAM 1	LAM 1	LAM 1	LAM 1	LAM 1
NET INCOME							
Total income before taxes.	TOTGINC83	.134794e+00	.174870e+00	.176867e+00	.180642e+00	.226416e+00	.225764e+00
		1.354	2.063	2.062	1.340	1.857	1.856
		(13.04)	(25.15)	(24.90)	(17.88)	(32.66)	(32.77)
		LAM 1	LAM 1	LAM 1	LAM 1	LAM 1	LAM 1
social security contributions	TOTSSC83	-.133028e+01	-.525563e+00	-.542335e+00	-.110521e+01	-.526531e+00	-.518242e+00
		-1.032	-.479	-.488	-.633	-.333	-.329
		(-26.29)	(-13.13)	(-12.63)	(-22.34)	(-16.85)	(-16.60)
		LAM 1	LAM 1	LAM 1	LAM 1	LAM 1	LAM 1
income taxes	TOTTAX83	.697139e+00	.200837e+00	.203754e+00	.625322e+00	.197420e+00	.196564e+00
		.857	.290	.291	.568	.198	.198
		(16.50)	(5.30)	(5.21)	(15.14)	(6.38)	(6.42)
		LAM 1	LAM 1	LAM 1	LAM 1	LAM 1	LAM 1
REGRESSION CONSTANT	CONSTANT	-.398535e+02	-.803878e+03	-.806790e+03	-.902331e+02	-.602839e+03	-.606632e+03
		-.097	-2.300	-2.281	-.162	-1.199	-1.210
		(-1.37)	(-21.26)	(-20.41)	(-3.18)	(-19.44)	(-19.42)
PARAMETERS (UNCOND. T-STATISTICS) / (COND. T-STATISTICS)	COLUMN / DEP.VAR. =	1 TOT1SAV83	2 TOT1SAV83	3 TOT1SAV83	4 TOTSAVCAR83	5 TOTSAVCAR83	6 TOTSAVCAR83
BOX-COX TRANSFORMATIONS: [T-STATISTICS=0] / [T-STATISTICS=1]							
LAMBDA(Y) - GROUP 1	LAM 1	1.000	.481	.477	1.000	.595	.595
		FIXED	[41.77]	[41.48]	FIXED	[46.54]	[46.94]
			[-45.12]	[-45.40]		[-31.64]	[-31.90]
LAMBDA(X) - GROUP 1	LAM 1	1.000	.481	.477	1.000	.595	.595
		FIXED	[41.77]	[41.48]	FIXED	[46.54]	[46.94]
			[-45.12]	[-45.40]		[-31.64]	[-31.90]
AUTOCORRELATION							
ORDER 13	RHO 13			.072			-.027
				(1.75)			(-.59)
GENERAL STATISTICS	COLUMN / DEP.VAR. =	1 TOT1SAV83	2 TOT1SAV83	3 TOT1SAV83	4 TOTSAVCAR83	5 TOTSAVCAR83	6 TOTSAVCAR83
LOG-LIKELIHOOD		-2497.082	-1932.593	-1931.771	-2487.392	-2215.989	-2215.859
PSEUDO-R2 : - (E)		.975	.986	.986	.983	.987	.987
- (L)		.975	.998	.998	.983	.995	.995
- (E) ADJUSTED FOR D.F.		.975	.986	.986	.983	.987	.987
- (L) ADJUSTED FOR D.F.		.975	.998	.998	.983	.995	.995
AVERAGE PROBABILITY (Y-LIMIT OBSERV.)		.094	.017	.017	.074	.025	.025
SAMPLE : - NUMBER OF OBSERVATIONS		426	426	426	426	426	426
- FIRST OBSERVATION		14	14	14	14	14	14
- LAST OBSERVATION		439	439	439	439	439	439

(2) Portfolio investments are a superior good; households spend about 20 Pfennigs of each additional DM of income on savings.
(3) Households reduce savings because they make contributions to the Social Security System, as a portfolio approach and the extended life cycle theory leads us to expect: each additional DM spent on Social Security reduces savings by half of that value.
(4) The more people live in a household, the more portfolio investments fall: each additional person reduces savings by slightly more than DM 20.
(5) Savings increase with age if cars are excluded from the portfolio, in apparent contradiction to the life cycle theory. However, once cars are included, age has no effect on savings. We suspect that older people reduce car purchases with age and, consequently, compensate the first influence.
(6) Rising taxes increase savings: this unexpected result could easily be explained by a detailed analysis of household categories, such as that performed by the present authors with 1978 data. It appears that in a sample of the whole population, results that hold for low income people (whose savings are tax exempt) dominate the sample.
(7) To develop this last point further, results obtained here for the population as a whole very closely resemble those found for low income white collar workers (as contrasted to self employed and to high income white collar, high and low income blue collar workers) with the 1978 sample. This is not surprising as they can be seen as an "average" category.

3.4 Heteroskedasticity and Autocorrelation Structures

The reference model assumes a spherical distribution of the residuals. However, it is by no means obvious that error variance is constant in the population or that autocorrelation is absent.

We found that, once we tested for the existence of heteroskedasticity, using either income or taxes as variable according to (4), the X'X matrix could not be inverted. We therefore had no choice but maintain our hypothesis that our residuals are homoskedastic.

We found no autocorrelation, in contrast to our earlier study where autocorrelation was either positive (high income white collar workers exhibiting a "keeping up with the Joneses" behavior) or negative for other workers categories. As shown in Columns 3 and 6, autocorrelation somehow averages out to zero. Of course, in a heterogeneous sample the notion of next richer household looses much of its economic relevance.

4. CONCLUSION

The evidence presented here is consistent with the view that car purchases are true investments in the households' portfolios. The only behavioral difference between the two specifications is associated with the age of the household head variable and consistent with a loss in relative importance of car purchases once people reach a certain age.

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